

## LOCAD Field Tests and Scientific Expeditions

A major component of instrument development for the LOCAD team is extensive operational tests in the field to support scientific expeditions. Field sites are often extreme environments that to mimic some of the conditions expected on Mars or the lunar surface. Listed below are a few of the extreme environments and scientific expeditions in which LOCAD instruments have been tested. For more information regarding the data collected during these tests, procedures, and the LOCAD technologies utilized, please see our Publications page.

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### Parabolic Flight Tests (2003 - 2009)



- ✚ Parabolic flights are flown by NASA's Reduced Gravity program, based at NASA Johnson Space Center in Houston, TX.
- ✚ NASA uses C-9 and KC-135 aircraft to fly parabolic arcs between 24,000 feet and 33,000 feet.
- ✚ Each parabola allows onboard researchers to perform tests in 20 - 30 periods of microgravity, lunar gravity or Martian gravity.
- ✚ Space Station crew procedures were tested in parabolic flight before launch; tests continue in order to further improve procedures.

**Photographs. Top:** Jake Maule tests LOCAD-PTS Reader in microgravity during parabolic flight over the Gulf of Mexico. **Bottom:** Maule and Norm Wainwright test dispensing procedures.

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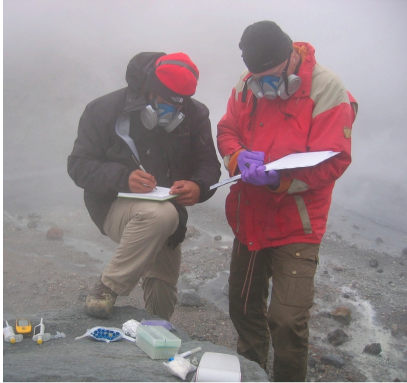
### • Arctic Mars Analogue Svalbard Expedition (AMASE) (2004 - 2009)



- ✚ Svalbard is a group of islands in the high Arctic located at 80°N, 300 miles north of Norway.
- ✚ The AMASE principal investigator is Andrew Steele (Carnegie Institution for Science).
- ✚ LOCAD-PTS used to monitor biological contamination of rock and ice samples, and to validate cleaning procedures.
- ✚ LOCAD-PTS used to test samples collected by robots and human operators to simulate surface operations on Moon/Mars.

**Photographs. Top:** Jake Maule uses LOCAD-PTS to test geological samples in a lunar prototype Mark III spacesuit. **Bottom:** The JPL Cliffbot hands off a rock sample to Maule during simulated EVA. Photographs © Kjell Ove Storvik.

## Volcano Expeditions to Kamchatka, Russia (2004 - 2006)



- ✚ Kamchatka is a peninsula in far eastern Russia, known as the land of 'Fire and Ice', and one of the most active volcanic regions in the world.
- ✚ NASA Astrobiology Institute (NAI) sponsored annual Volcano Expeditions to Kamchatka in 2004 - 2006.
- ✚ LOCAD-PTS was used to detect endotoxin in basalt and ice surrounding active volcanoes, such as Kluchevsky in northern central Kamchatka.
- ✚ LOCAD-PTS was used to detect endotoxin in drill cores of permafrost on slopes of Tolbachik Volcano.
- ✚ LOCAD-PTS and ATP (Adenosine Tri-Phosphate) luminometry was used to detect endotoxin/ATP in boiling hot pools within active volcanoes.

**Photographs. Top:** Eruption of Kluchevsky Volcano. **Bottom:** Jake Maule and Jan Toporski use LOCAD-PTS to test for endotoxin in boiling acid pools in the crater of Mutnovsky Volcano.

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## Desert Research and Technology Study (Desert RATS) (2005 - 2006)



- ✚ The Desert RATS is a NASA-led team of research partners working together to prepare for human-robotic exploration. This "working group," led by NASA personnel, is comprised of both NASA and non-NASA Members.
- ✚ LOCAD Science Team worked with extra-vehicular activity (EVA) technicians to develop procedures to limit biological contamination of spacesuit gloves during EVA preparation and cleanup.
- ✚ LOCAD-PTS swab sampling and analytical procedures were integrated into simulated surface extra-vehicular activity (EVA) at Meteor Crater and Cinder Lakes, Arizona.
- ✚ LOCAD Science Team worked alongside EVA planners to integrate planetary protection monitoring and a simulated search for life into EVA plans.

**Photographs: Top:** Ken Splawn uses the LOCAD-PTS swab device to monitor microbes on his own spacesuit on the slopes of Meteor Crater, Arizona, during simulated surface EVA. **Bottom:** Jake Maule swabs Ken's gloves before and after EVA and tests those swabs for endotoxin at Cinder Lakes, Arizona, a site used by astronauts to prepare for Apollo 15 – 17 during 1969 – 1972.

## NASA Extreme Environment Mission Operations (NEEMO) (2003)



- ✚ NEEMO -- the NASA Extreme Environment Mission Operations project -- sends groups of NASA astronauts to live in the Aquarius habitat for up to three weeks at a time. For NASA, Aquarius provides a convincing analog to space exploration, and NEEMO crewmembers experience some of the same tasks and challenges underwater as they would in space.



- ✚ LOCAD-PTS was selected as an experiment for NEEMO 5 (PI: Jake Maule), where crew used LOCAD-PTS for microbial monitoring in Aquarius. Astronauts Clayton Anderson and Garrett Reisman analyzed areas including the kitchen and wet porch.
- ✚ Swabs were analyzed in the habitat and then brought to the surface for subsequent culture-based analysis by the Microbiology Group at NASA Johnson Space Center (Co-PIs: Mark Ott and Duane Pierson).

**Photographs:** **Top:** Aquarius habitat, located 62 feet below the surface. **Bottom:** Astronaut Clay Anderson swabs inside Aquarius.

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